

A Comparative Study of Environmental Effect of Green Buses to Existing Public Transport

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Abstract

Developing economies observe a unique phase of population growth, economic growth as well as urbanization. As one-third of Indian population lives in urban area; and so road transport dominates. Public transport existence is quite uneven in developing cities and where-ever a reasonable level of service is offered it has attracted ridership. Bus-based service all together comprises about 90% of public transport. In cities increasing travel demand, dependence on private vehicle mode and declining public transport mode will increase energy demand and CO₂ emission from cities. The research is carried to analysis the environmental parameter CO₂ emission of existing public transportation with respect to Green bus and to perform comparative analysis of traffic parameters i.e. queue length and travel time between existing and green bus as a mode of public transportation of selected route by using PTV Vissim and EnViVer software. The Green bus has potential to reduce the CO₂ emission about 26.71% which helps to improve air quality of the city, the travel time is increased by 16.73% and 8.50% on north bound and south bound respectively of Green bus due to its bus characteristics, and it provides safety and comfort to the user. The queue contributes 15.34% more by existing public transport as compared to Green bus. Thus alternative fuel such as CNG can be used effectively to lower the environmental impact; and public transportation infrastructure should be developed to provide accessibility and safety to user.

Keywords: Public Transport, Green Bus, CO₂ emission, Traffic Volume, Travel Time and Queue Length

I. INTRODUCTION

Developing economies observe a unique phase of population growth, economic growth as well as tremendous urbanization. As one-third of Indian population lives in urban area and so road transport dominates [5]. The public transport infrastructure should be developed so as to achieve effective, safe and efficient transport system to user; one of the approaches for it is to strengthen the existing public transport. A good public transport will promote the mobility, will overcome the pollution and reduce the traffic congestion, accident on road network. The observation suggest that high increase in vehicular population and transportation demand is caused due to urbanization i.e. population growth and also change in travel demand on the corridors. This increase in vehicles causes environmental pollution such as air and noise pollution; which leads to lower the quality of life and affects the health of habitants adversely. There is enormous need to study this parameter and recommend proper measures which can be adopted. The past studies and science indicates that atmospheric CO₂ is the major factor of causing Global warming and climate change, and it has become a severe problem all over the world.

The bus penetration in India is 1.29 buses per thousand of population which is very low when comparing it with 2.93 of United Kingdom, 2.77 of United States, 1.83 of Japan and 1.35 of France; which enhance the current scenario of public transport in India [6]. The existing situation of public transport can also be characterized by its increasing trip length, increasing mode share of private vehicles and declining share of public transport. Thus; it tends to result into poor air quality, noise, irrelevant road safety and congestion. Green Bus is a technology which runs on Compressed Natural Gas (CNG) fuel type, this kind of buses is non-polluting, clean and affordable. Green bus provides various facilities to the passenger like safety, comfort, automated and convenient. It has lower emission so it provides sustainable future and environment friendly public transportation in India [8].

There are several researches done theoretically in recent years, the research paper have been conducted to evaluate most dominated variable CO₂ emission. Kakouei et al. (2012) considered four major vehicles like bus, taxi, private car and motorcycle which moved in the city to measure fuel consumption and CO₂ emission from them. They have developed a mathematical model with a macro-scale approach was used to estimate the CO₂ emissions of each type of mentioned vehicles. Form the model it is found that urban transport operation consume an estimated 178 and 4224 million liter diesel and petrol per year respectively, and release about 10 million tons of CO₂. It concludes high traffic volume, transport consumption of fossil fuels and shortage of adequate public transport system are responsible for the high CO₂ level in environment of Tehran city. ZHANG et al. (2013) conducted study to know the impact of the low-carbon constraints on the route and mode choices of trip makers of transportation

network which are composed of buses and private cars. The equilibrium solution of the proposed combined model split or traffic assignment model is given by developing generalized lagrangian multiplier solution method which is tested in two hypothetical test networks. The optimized results of the model provides transportation planners information to estimate the expected proportion of traffic demand shared by buses and private cars under the influence of various low-carbon constrains. Rakesh et al. (2014) determine the impact of public bus transit by using binary logit analysis for investigating the variation in modal shift behaviour of user. The study of mode choice was developed, calibrated and validated by using socio-economic parameter. Traffic parameter such as delay, speed, travel time and congestion is modeled in VISSIM. The study result shows the promising output of modal shift and developing a sustainable public transport system. LINH LE and TRINH (2016) study is to encourage use of bus service to reduce pressure on urban environment and traffic, and to recognize the behaviour of mode choice among student and employee. To achieve this binary logit model was used under disaggregate choice model which is examined on student and employee and various factor were considered which affect their mode choices. The model is calibrated motor cycle and bus transport of HCM city and it is validated. The result shows dependency on private vehicle is more and their willingness to modal shift by improving the quality of bus service.

The research is to analysis the environmental parameter CO₂ emission of existing public transportation with respect to Green bus and to perform comparative analysis of traffic parameters i.e. queue length and travel time between existing and green bus as a mode of public transportation. The comparative analysis is done with the help of PTV Vissim and Enviver Software.

II. THEORETICAL CONSIDERATION

A. Study Area

Nanded city is district of Maharashtra State. It lies between 19.15° North Latitude 77.3° East Latitude and Nanded city covers an area 51.76 Sq. km. The city is divided in two parts one is old Nanded which covers 20.62 Sq. km. and other is new Nanded it covers 31.14 Sq. km., comprising Waghala and six other newly merged villages. As of the 2011 census, it had a population of 550,564; it is small to medium size city. Nanded is one of the ancient and historical place in Maharashtra and it has spiritual significance for Sikh pilgrimage [9]. The climate condition of the city is usually dry apart from during southwest monsoon season which occurs in the first week of June and remains about 2.5 to 3 months [10].

The city bus service and three wheeler service is provided as public transport system in the city. Study area has seven bus routes carrying bus operation over it and it has few common stops which shares with CBD of the city, it is overlapping route type. This route covers major location of the city as it collect passenger from various area like residential, working and commercial. From all the seven routes we are going to consider major corridors of the city, as all the bus routes terminate out of the main city which consists of less traffic volume. The routes which have been selected are the core area and have high travel demand in this corridor. There is an immense need to provide public transport to user to satisfy this travel demand with good service and facilities. The selected study route covers important corridors of the city as it consist of residential, institutional and commercial area. The selected route also makes easy accessibility to the public facilities like Main bus stand and Railway station to user.

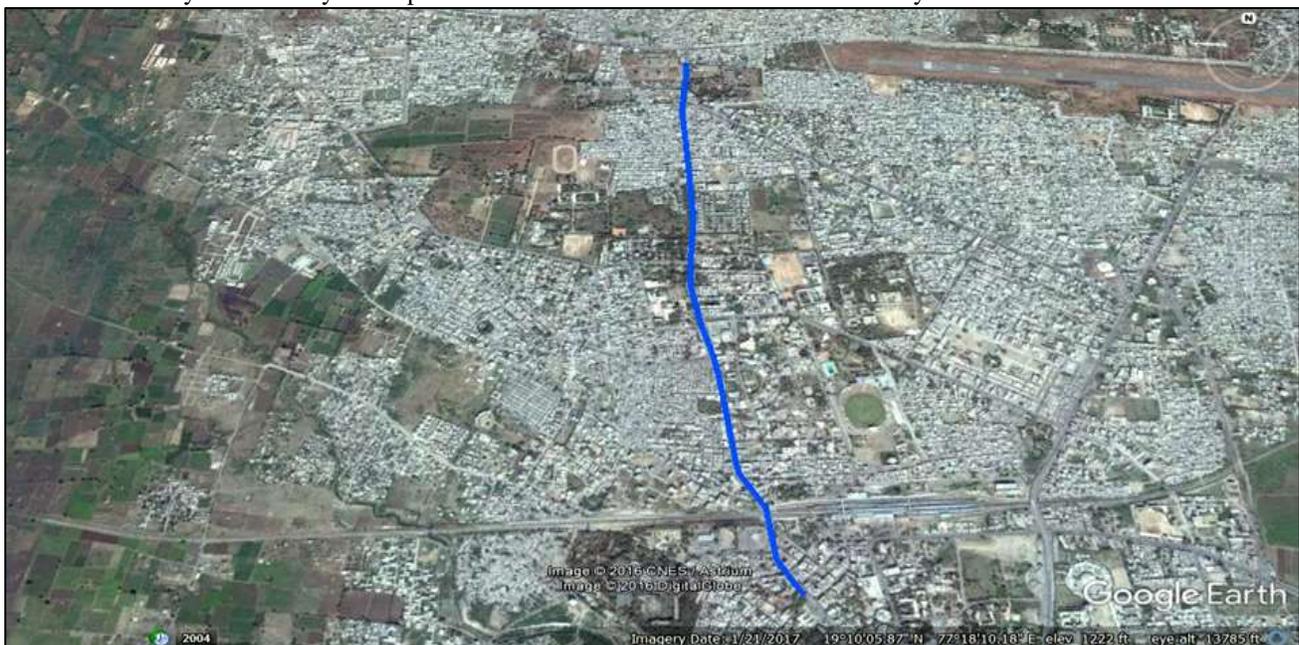


Fig. 1: Study Area (Source: Google Earth)

B. Data Collection and Analysis

According to the aim of the study the analysis of the CO₂ impact of the public transport system evaluated using PTV Vissim and Enviver software. Simulation of public transport system using microscopic traffic simulation software named as PTV Vissim as it able to simulate multi-modal transport and multiple vehicle type. It provides detailed presentation of the road network and vehicle movement and it give realistic result. Enviver is emission modeling software produced by TNO, which is based on the large empirical database (VERSIT and models). It provides the result based on operational level and considering individual vehicle characteristics.

In this research study area data collection is conducted in two forms primary and secondary respectively. In primary data collection traffic characteristics as traffic volume, signal timing, and dwell time at bus stops are collected for the analysis. For CO₂ impact analysis most dominated variable is bus Characteristics like mileage, operating condition, life, Operating speed, capacity. The public transport in study area is city based bus system and it consist of seven routes there scheduling and routing, and width of carriageway collected as secondary data from State Road Transport Cooperation.

The bus survey provides the detail information of dwell time required for the passenger boarding and alighting at every bus stop and delay causing due to signal stops, the dwell time is necessary to check the passenger facilities provided to the users. The traffic volume in the city is calculated for primary and secondary streets of the study route which is then converted into PCU/Hr.

The model is developed for analysis in PTV Vissim; evaluation is completed in two stages, firstly the existing public transport is modeled and then the Green bus is modeled on the same network with same traffic condition. The simulation results are exported in EnViVer software then it analyses CO₂ emission parameter in it. The figure shows location of bus stops considered in the study route.

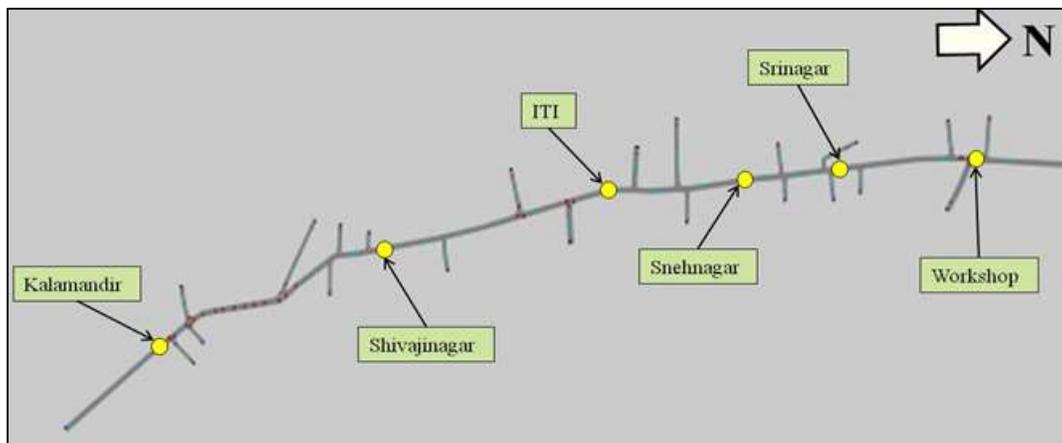


Fig. 2: Network Model in PTV Vissim

III. RESULT AND DISCUSSION

A good Public transport plays an important role in any strategy to achieve a sustainable transport system. The varying and undeveloped public transport systems have led to increased reliance on private vehicles among urban population.

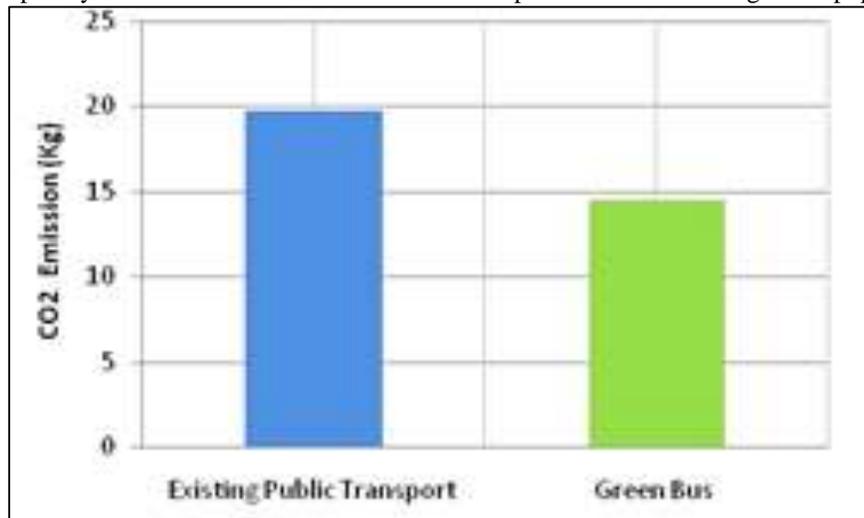


Fig. 3: Evaluation of CO₂ Emission

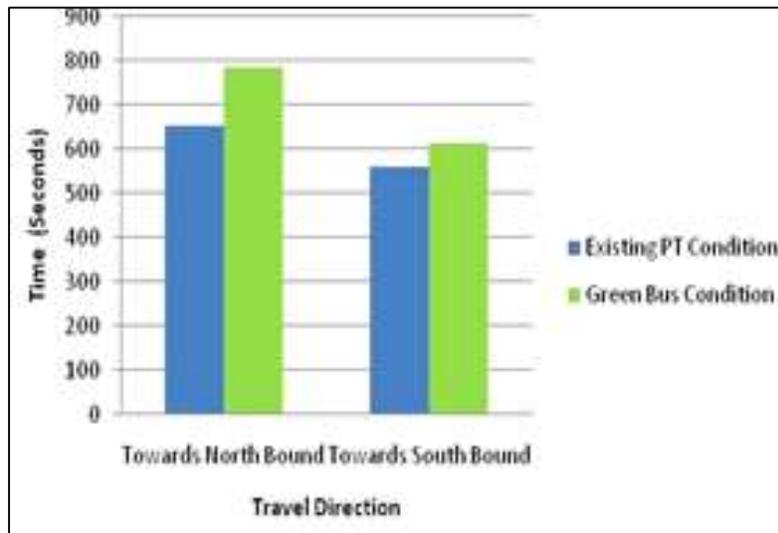


Fig. 4: Evaluation of Travel Time

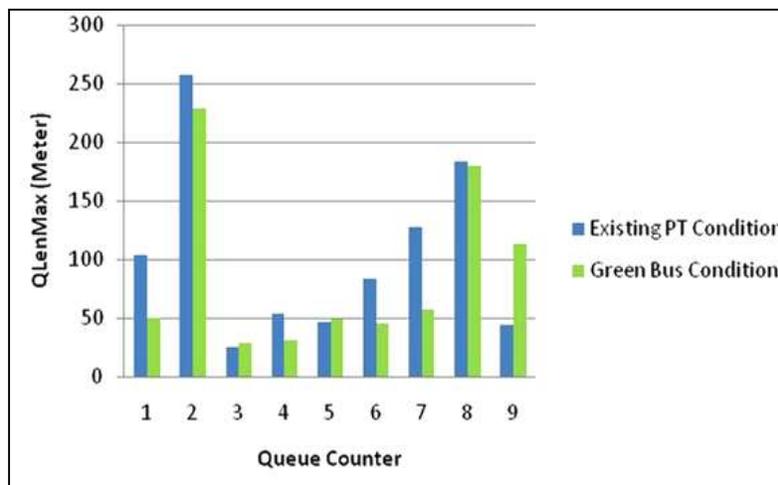


Fig. 5: Evaluation of Queue Length

The CO₂ emission modeling of the study route is done in EnViVer software. The results are generated from the number of trips of bus during simulation period i.e. one hour modeled in PTV Vissim as in fig. 1, X-axis represent as public transport condition and Y-axis represents CO₂ emission in Kilogram. The emissions are 19.744 Kg and 14.470 Kg of CO₂ per hour for four bus trip of an existing public transport and Green bus respectively. The Green Bus emits 26.71% less CO₂ as compared to the existing public transport.

Travel time of Green Bus is increasing by 16.73% and 8.50% of north bound and south bound respectively; due to its dwell time required for automatic opening and closing of doors at bus stop, as this facility increases safety of the passenger. The X-axis represents the travel direction of the study route; link towards North bound and link towards south bound drawn as in PTV Vissim Network and Y-axis represents travel time in seconds. The existing transport does not consist of this automated facility as the doors are always open.

The queue length on an average is reduced upto 15.34% of Green Bus condition that of existing public transport as the dimensions of bus which are different, X-axis represents the number of queue counter placed at various bus stops in both direction of the network for measuring queue length in PTV Vissim. The queue is measured only at bus stop to get accurate result of queue caused by bus only.

IV. CONCLUSION

In this study, we estimated CO₂ emission and traffic parameter of selected study route. The evaluation of present level of air pollution of the city is required to check the sustainability of the public transport.

- The Green Bus is an efficient alternative fuel type can be used in public transport, which facilities better air quality to the user than the existing public transport as it helps to reduce CO₂ emission and its environmental impact.
- From the study, travel time contributed more by the Green bus as compared to existing public transport this due to its bus characteristics and queue length can be reduced if the bus stops infrastructure is developed.

The study areas bus transit system still does not provide service to all corner of the city so there is a need to cover all area of the city; and waiting time should be also reduced to encourage the user to use public transport and to decrease the dependency of private vehicle. The Public transport infrastructure should be developed effectively and adequate such that the waiting of the user at stops should not affect the traffic flow and safety of the user should be maintained.

REFERENCES

- [1] Kakouei et al., (2012), “An estimation of traffic related CO₂ emissions from motor vehicles in the capital city of, Iran”, Iran Iranian Journal of Environmental Health Sciences & Engineering, pg no.01–05.
- [2] ZHANG et al., (2013), “Modeling the Effects of Low-carbon Emission Constraints on Mode and Route Choices in Transportation Networks”, International Conference of Transportation Professionals, pg. no. 329 – 338.
- [3] Rakesh et al., (2014), “Introduction of public bus transit in Indian cities”, International Journal of Sustainable Built Environment (Vol. 3), pg no. 27-34.
- [4] Linh Le & Trinh (2016), “Encouraging Public Transport Use to Reduce Traffic Congestion and Air Pollutant: A Case Study of Ho Chi Minh City, Vietnam”, Sustainable Development of Civil, Urban and Transportation Engineering Conference, pg. no. 236 – 243.
- [5] Article “Current Transport Scenario in India” at academlib.com
- [6] Article “Current Transport Scenario in India” by U. Sudhakar Rao, Indian Journal of Transport Management.
- [7] Dhar et al., (2016). “Conceptualizing sustainable low carbon urban transport in India”, editorial.
- [8] http://en.m.wikipedia.org/wiki/Delhi_Transport_Corporation
- [9] <http://en.m.wikipedia.org/wiki/Nanded>
- [10] www.nwcmc.gov.in